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HIGH FREQUENCY RADIO USERS GUIDE TO AFGWC PRODUCTS.(U)
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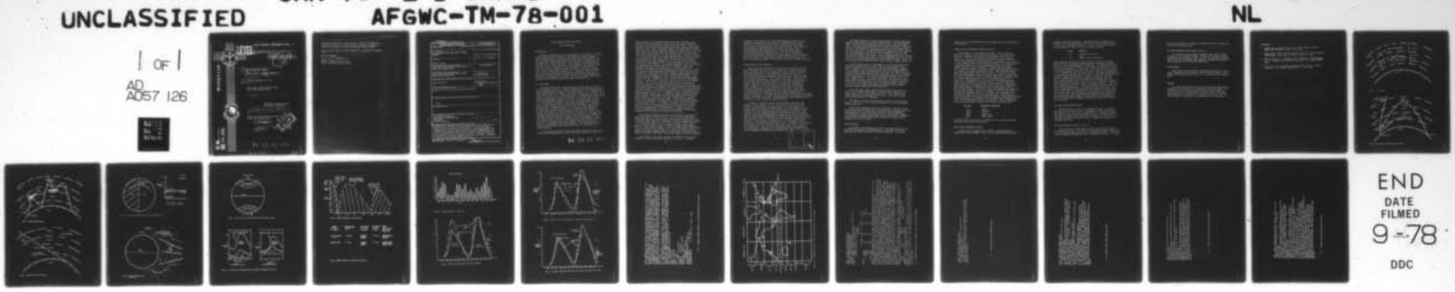

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AFGWC TECHNICAL MEMORANDUM 78-001

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6 HIGH FREQUENCY RADIO
USERS GUIDE TO AFGWC PRODUCTS.

10 Edward D./Beard, CMSgt, USAF

HQ Air Force Global Weather Central
Offutt AFB, Nebraska 68113

9 Technical memo,

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Distribution Unlimited

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HQ Air Force Global Weather Central
Offutt AFB, Nebraska 68113

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This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

Donald C. Hansen

DONALD C. HANSEN, Colonel, USAF
Chief, Technical Services Division

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Ionosphere
Particle Radiations

the Air Force Global Weather Central

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

High Frequency (3-30 Mhz) radio waves used for long range communications networks are at the mercy of natural variations in the earths upper atmosphere, more specifically, the ionosphere. This guide explains these variations and describes various products available from (AFGWC) which can alert the system operator of observed or predicted solar and geophysical activity which can affect HF circuit reliability. The guide is basic and was designed with the field communicator in mind, but contains information of value to circuit managers and supervisors.

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HIGH FREQUENCY RADIO USERS GUIDE

TO AFGWC PRODUCTS

INTRODUCTION.

The use of radio waves in the high frequency (HF) range (3 to 30 MHz) is an economical means of relaying information over large distances. Communications may be successfully established over paths thousands of miles in length because of the presence of the earth's ionosphere. The ionosphere is an electrified layer in the atmosphere extending upwards from about 30 to beyond 1000 miles. The strength of the ionosphere is directly related to the intensity of electromagnetic and particle radiations from the sun. Therefore, variations occur in the electrical properties of the ionosphere from day to night, from season to season, and in concert with 11 year sunspot cycle. Other more impulsive variations occur in conjunction with energetic solar flares. Some understanding of these variations, and the use of certain AFGWC products may permit the HF communicator to identify the source of many communications problems, and to perhaps lessen their impact on operations.

THE IONOSPHERE.

Surrounding the earth at high altitudes are near spherical "shells" of free electrons (Slide 1). During the daytime hours these shells exhibit certain properties which permits the classification of the ionosphere into three distinct layers or regions. The lowest region (35 to 55 Miles) is called the D region. It is this region which is responsible for most of the signal loss which occurs on HF radio circuits. The next higher layer is the E region which extends from 55 to 90 Miles. The E region will reflect certain HF frequencies, particularly during the summer months when the sun is most directly overhead. On occasion, an exceptionally intense layer of electrons will form in the E region (Sporadic E). This region may be intense enough to reflect any HF (and often VHF) signal which encounters it. The highest layer, the F region, extends outwards in the atmosphere to about 1000 Miles, but is strongest near 200 Miles. Most HF radio waves are "bent" towards the earth in the F region. The stronger (or greater the electron density) the region is, the higher the frequency radio wave that will be bent. Electrons in the ionosphere are "stripped" from parent atoms and molecules by the absorption of radiations from the sun. The solar radiations may be electromagnetic (X-rays and extreme ultraviolet rays) or particulate (protons, electrons and neutrons). The intensities of both types of solar radiations vary directly with changes in the solar atmosphere. The appearance of large sunspots, and impulsive solar flares will result in an increase in solar radiation.

X- and extreme ultraviolet (EUV) radiations from the Sun serve to excite certain constituents in the earth's upper atmosphere to the point

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where electrons are physically expelled into the surrounding space. Particles accelerated outwards from the sun collide with atoms and molecules in the ionosphere and produce the same effect. These "freed" electrons then interact with passing radio waves, sometimes absorbing the waves energy. These interactions may be vigorous enough to totally absorb the radio energy, completely degrading a communications link. At other times, the electrons may inject unwanted noise into the signal resulting in severe "static" at the receiving end. A third effect may be to "split" the signal into several separate waves so that a given bit of intelligence on the initial signal will arrive at the receiver at slightly different times "washing" it out (distructive multipath). These effects are mainly induced in the lower parts (30 to 100 miles altitude) of the ionosphere. In the upper ionosphere (100 to 200 miles) large populations of free electrons are desirable in that higher frequency radio waves can be bent back to the earth (Slide 2). Generally, the higher HF radio frequencies are the best to use as they are less affected by absorption and atmospheric noise than the lower frequencies. Under ideal conditions, the main energy associated with the radio wave propagates in a fairly straight forward manner. The signal leaves the transmitter, loses a small amount of energy passing through the lower ionosphere, (30 to 35 miles) then continues upwards to the "F" region, (180 to 200 miles) where it is "bent" or refracted downwards. The signal is attenuated again passing through the "D" region, but much of the orginal radio energy which is transmitted reaches the receiver. Under more complicated ionospheric configurations, radio signals pass from transmitter to receiver along a varity of paths (or modes) (Slide 3). Here we have an example of a radio path where the signal is first reflected from a "Sporadic E" layer, the ground, the F region Sporadic E again, etc. On longer HF paths, a mixed propagation mode is probably more common than the simple mode exemplified in the previous slide. At this point it might be appropriate to include a point, often neglected by many HF users. Radio signals generally travel from transmitter to receiver along a path of shortest distance (a great circle route). For example, an HF path from the Far East to the West coast of the U.S. will pass over Japan, skirt the Aleution chain, run parallel south-eastward along the Canadian-U.S. Pacific Coast before terminating in the Western U.S. This path would be seriously degraded during an Auroral Zone disturbance although both transmitter and receiver are at fairly low latitudes.

The preceding examples are typical of conditions to be expected when an HF circuit is totally sunlit. The situation becomes more complicated when the sun is rising or setting on an HF path (Slide 4). In the dark area, the D and E regions are virtually nonexistent, and the F region is quite weak due to the lack of ionizing radiation from the sun. Conversely, the D, E and F regions are strong in the sunlit section. This situation leads to a reduced maximum usable frequency (MUF) and lowest usable frequency (LUF) in the dark segment, and elevated values in the sunlit area (Slide 5). During the sunrise transition period, the usable frequency spectrum becomes quite limited, and under certain conditions the "window" closes and propagation becomes impossible.

The ionosphere over lower latitudes is maintained mainly by the incident X- and EUV radiations from the sun (Slide 6). At higher

latitudes, solar radiation must penetrate greater thicknesses of the atmosphere, and becomes less effective in maintaining the D region. However, it is at these latitudes where the earths magnetic field lines become more perpendicular to the earths surface. This configuration provides a guiding path for charged particles from space to penetrate deeply into the atmosphere. Collisions between these charged particles and atmospheric gases result in an increase in electrons in the auroral zone and polar cap D region. Even during quiet solar-geophysical conditions, a steady "precipitation" of charged particles occurs into these higher latitude zones and consequently the LUF is generally greater in these areas than over the lower latitudes.

SOLAR EFFECTS ON THE IONOSPHERE.

When large solar flares occur, large doses of X-rays are emitted. The X-rays travel from the sun to the earth at the speed of light and penetrate deeply into the ionosphere on the sunlit side of the earth. This sudden disruption to the ionospheric D region results in the strong, and often total, absorption of HF radio waves. This is called the Short Wave Fade (SWF). Normally, SWFs last about 30 minutes, but with strong flares may last 1 to 2 hours. The onset of the fade is quite abrupt, with the lower frequencies first to drop out and last to recover. When the large flare occurs, particles are accelerated outwards from the sun and these particle streams may intercept the earth. Normally, the highest energy particles from a solar flare reach the earth some two to six hours after the flare. This cloud of charged particles is composed mainly of high energy protons which are directed into the earth's polar caps causing ionization and absorption (Slide 7). The absorption will last about two days during which time HF communications of paths crossing the polar regions will be seriously degraded or totally impossible. The degradation of HF communications in this area is called a Polar Cap Absorption (PCA).

Generally, a large solar flare which produces a PCA, will also produce a major geomagnetic storm. The flare will accelerate large volumes of slower moving, low energy particles at the same time the faster, high energy particles are expelled. The lower energy particles normally take 2 to 3 days to travel from the sun to the earth. These particles are also deflected by the earth's magnetic field lines and eventually enter the upper atmosphere around 55 to 65 degrees from the equator. This particle bombardment into what we describe as the "auroral zone" produces intense ionization, brilliant displays of the Northern and Southern lights (Aurora), and degradation of HF radio communications (Slide 8). This phenomena is generally called a "geomagnetic storm". An individual storm may last three days or so. On occasion, a particularly active solar region will produce several major solar flares over a 10 to 14 day period. Each flare will contribute to PCAs and geomagnetic storms already in progress so that HF communications over high latitudes will be degraded or nonexistent for days on end.

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The normal sequence of events associated with a single large flare may be illustrated as a function of time (Slide 9). The most immediate effects on an HF system noted with a flare will be "short wave fades" (SWF). This fade will be observed only in the sunlit areas of the earth and with a large flare may last up to two hours. Some two hours after the flare, the first high energy protons will reach the earth and produce polar cap absorption. The PCA will be the strongest during the first six to twelve hours after onset, but full recovery may not occur for some two and a half to three days. Often as communications are returning to normal in the polar cap regions, a major geomagnetic storm will set in with a return to degraded conditions at much lower latitudes. After a six to seven day period, conditions will finally return to normal (Slide 10).

As mentioned previously, the frequency of solar disruptions which affect the ionosphere will closely follow the solar sunspot cycle. The more sunspots on the solar disk, the more disturbances. Sunspots tend to exhibit a fairly regular pattern which can be approximated as a sine function, with a mean periodicity of about 11.5 years (Slide 11). A normal sunspot maximum will yield a number near 100, while the minimum value will be near 10. The most recent maximum occurred in late 1968 with a sunspot number of 110, while minimum was observed in mid 1976 with a number near 12. As a matter of interest, on occasion a "super" cycle will occur (most recently in 1958) where the sunspot number will be near 200. At present (Jan, 1978), the sunspot number is near 60, so we are well into the ascending phase of the next solar maximum (expected sunspot number near 150 in 1980-1981).

Short wave fades (SWFs) associated with solar flares will occur at the rate of about one per month at solar minimum, increasing to about one per day at solar maximum (Slide 12). This figure is only a mean value, as a particularly active region on the solar disk may produce several SWFs in a single day.

The number of PCAs will also follow the sunspot cycle trend with about one per year at solar minimum increasing to 12 to 15 per year at maximum (Slide 13).

Flare induced magnetic storms may be expected at the rate of two to three per year at minimum and 20 to 30 per year at maximum (Slide 14). (These figures do not include small non-flare associated magnetic disturbances which occur at the rate of one to two per month during solar minimum). Normally during these smaller disturbances, communications are not completely degraded but low power HF circuits may be disrupted for up to two days.

AFGWC BULLETINS

The upcoming solar maximum will result in a large increase in the number of disruptions to HF communications. This paper so far has described the causes and effects of these disruptions. Now we will

look at some of the AFGWC bulletins and explore their use in optimizing communications.

PRIMARY SOLAR-/GEOPHYSICAL BULLETIN (Slide 15).

This bulletin is issued daily near 2300Z. Part I contains a descriptive summary of solar active regions and of significant solar activity. Included is an outlook for the expected level of solar activity. Part II of this bulletin describes any solar geophysical events (PCA, geomagnetic storms) in progress or expected. Part III of this bulletin contains a probability of occurrence of minor (Class M), or major (Class X) solar events and proton events. Also included is a color-coded forecast for Polar Cap Absorption (PCAF). The word "GREEN" indicates no PCA is expected. "YELLOW" indicates that an active region is present on the sun which has favorable characteristics for a major flare which could produce a PCA. "RED" indicates that a major flare has occurred and a PCA is likely as a result of the flare. The words "IN PROGRESS" obviously indicate that a PCA is occurring at the time of the message. Part IV contains observed and forecast values of the radio emissions from the sun at the wavelength of 10.7 Cm (2800 MHz). This parameter is of little use to HF communicators by itself, but a comparison of the days value to the 90 day mean gives some indication of the overall level of solar activity. Generally, a value much higher (10 or more units) than the mean occurs when one or more active regions are present on the sun, and energetic activity will be fairly common. A value much lower than the mean will generally indicate that energetic activity is unlikely. Part V includes the observed and predicted indices of the state of the geomagnetic field. Of particular importance is the value called "Ap". This index may range from a value of 0 (extremely quiet geomagnetic conditions, generally good HF propagation conditions) to 400 (Extremely severe geomagnetic storm, greatly degraded propagation conditions). The Ap value may be converted to qualitative terms by the following conversion table:

Ap value	Geomagnetic Conditions
0-7	Quiet
8-14	Unsettled
15-29	Active
30-49	Minor storm
≥ 50	Major storm

The predictions can be of use to communicators in planning operations during the three day forecast period.

THE HF RADIO PROPAGATION REPORT

This bulletin is issued daily at 0600Z in the comprehensive format shown in this example. Part I of this bulletin is also updated

at 0000Z, 1200Z and 1800Z daily. This part contains a summary and a forecast of HF radio propagation conditions for 20 geographic sectors in the northern hemisphere (Slide 16). (Slide 17) Observed conditions are indicated by a letter using the following convention:

Letter	Condition
W	Unusable (Very Poor)
U	Fair
N	Normal (Good to Very Good)

These conditions are obtained from a variety of sources including discussions with operational HF communicators, data from ionospheric sounders, and observed geomagnetic conditions. The numerical indicator in this part is a coded forecast for communications conditions using a scale from 1 (poorest) to 9 (excellent). Also included in this section is a predicted percent deviation in the MUF on paths in the appropriate sector. Communicators may use these figures to plan which frequencies to use during the forecast period. Part II of the 0600Z message contains a general written description of ionospheric conditions and their effects on communications circuits during the previous radio day. This information may be used by communications managers for circuit analysis and quality control. Part III contains a summary of observed solar induced HF disruptions during the previous radio day. Inputs to this section may or may not include a confirmation that the solar flare affect the HF communications. If any HF system was affected by the flare an indication of what frequencies were affected is given. This section also contains a probability of the occurrence of a SWF during the next 24 hours. Part IV contains an observation and forecast for the 10.7 Cm solar radio emissions and geomagnetic activity indices. These parameters are the same as issued on the Primary bulletin, but may vary if additional information indicates the previous forecasts were in error.

THE AFGWC EVENT WARNING REPORT

This bulletin is issued on an "as required" basis. It may be generated by a variety of solar or geophysical events, each of which may impact on one or more military electronics or satellite systems. The event which precipitated the report is first described (Slide 18). Any known or implied system impacts are included, and if the event is expected to produce any further effects, a comment to elaborate is included (Slide 19).

THE AFGWC SEVEN DAY OUTLOOK (Slide 20).

This bulletin is issued weekly (Fridays, 0800Z) and is divided into three basic parts. The first part contains a forecast of the level of solar activity expected during the following seven days. The second section describes the expected level of geomagnetic activity. The last

part of the message is a forecast for general HF radio conditions for the seven day outlook period.

THE AFGWC EXTENDED PERIOD REPORT (Slide 21).

This bulletin is issued weekly (Mondays, 0800Z) and is similar in format to the SEVEN DAY OUTLOOK. The first two sections contain outlooks for the following 27 days for solar and geomagnetic activity. The last part of the message also contains a forecast for general HF radio conditions for the following seven days.

MISCELLANEOUS.

Other bulletins which contain information which may be of use to the HF communicator are described in AFGWCP 105-1, Volume IV. This pamphlet may be obtained by writing to: HQ AFGWC/DA, Offutt AFB, NE. 68113.

SUMMARY

This short guide greatly simplifies an extremely complex set of concepts on the influence of the ionosphere on HF radio waves. The intelligent use of several products available from the AFGWC can assist the HF user to optimize the use of the system. The proper identification of the source of HF disruptions is vital to the user and can provide alternatives for increasing circuit reliability.

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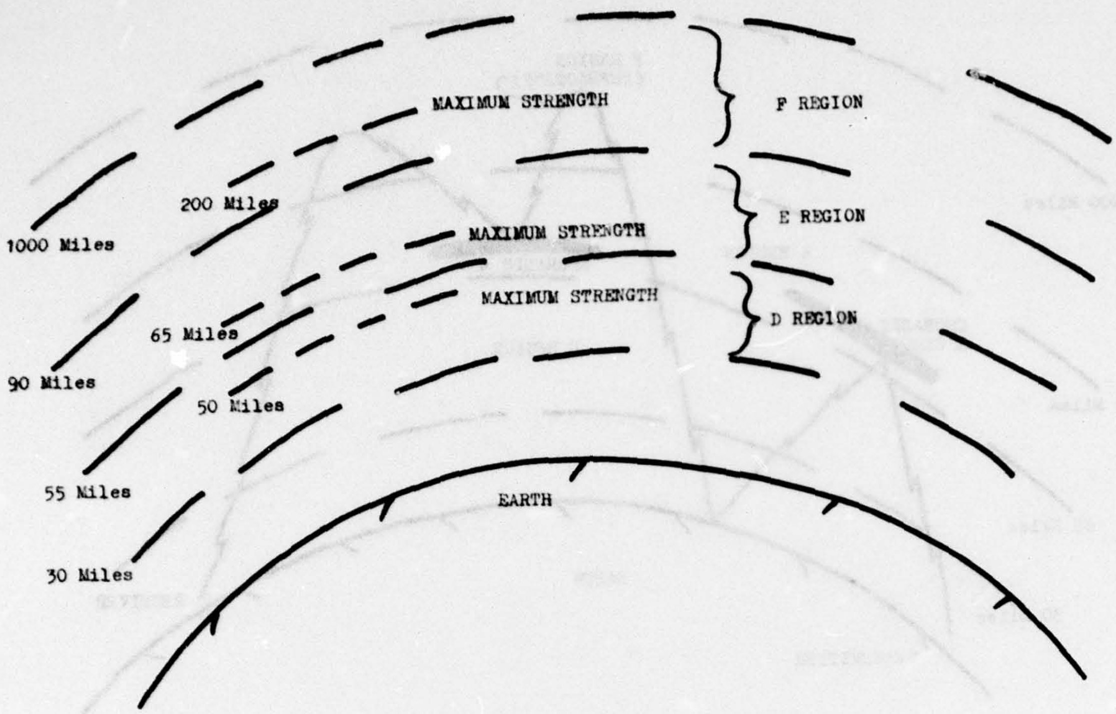
1. AFGWCP 105-1, Volume IV, HQ Air Force Global Weather Central, Offutt AFB, NE. 68113, 15 April 1977, 33p.

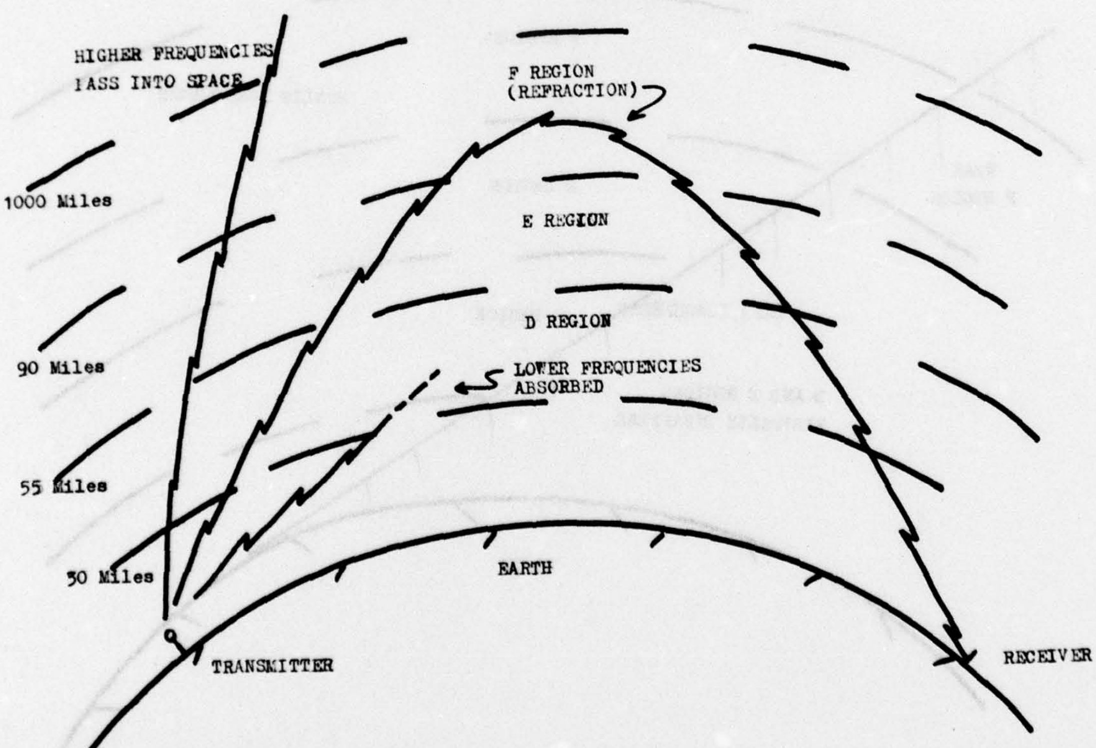
2. AWSP 105-36, "Guide to Solar-Geophysical Activity", HQ Air Weather Service (MAC), Scott AFB, IL. 62225, 12 July 1977, 38p.

3. Davies, Kenneth,: "Ionospheric Radio Propagation", NBS Monograph 80, U.S. Department of Commerce, Washington, D.C., April 1, 1965, 470p.

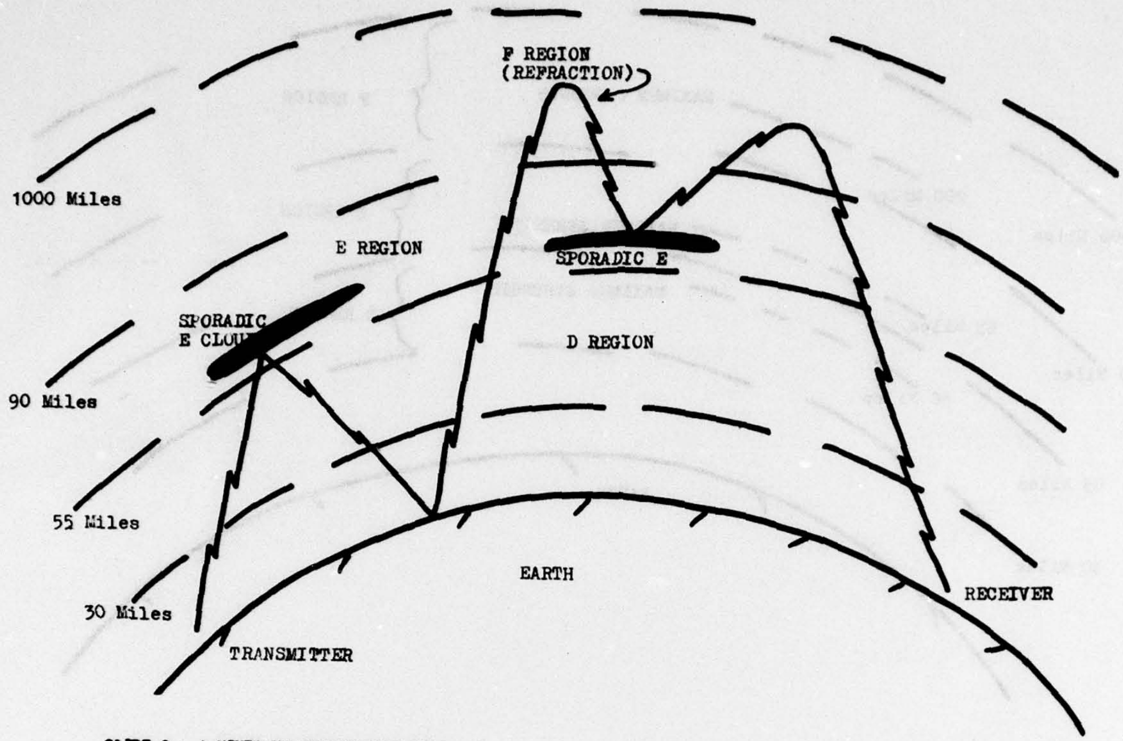
4. Ratcliffe, J.A.: Sun Earth, and Radio, World University Library, McGraw-Hill Book Company, New York, N.Y., 1970. 256p.



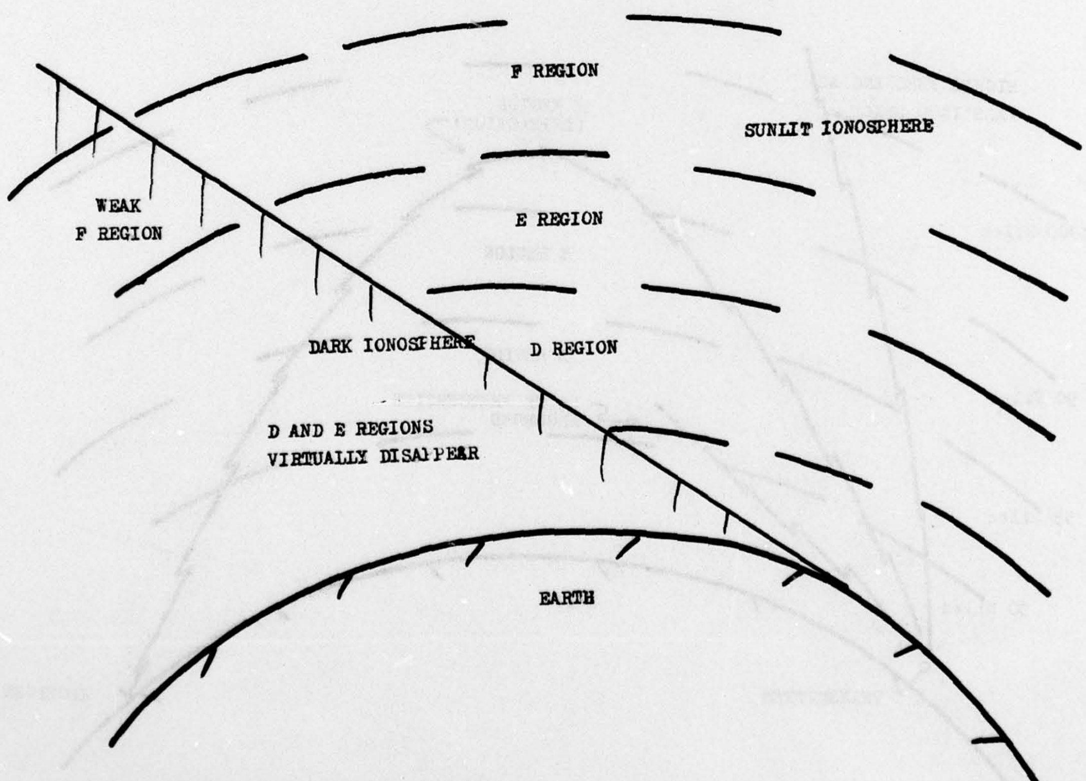
SLIDE 1. THE IONOSPHERE



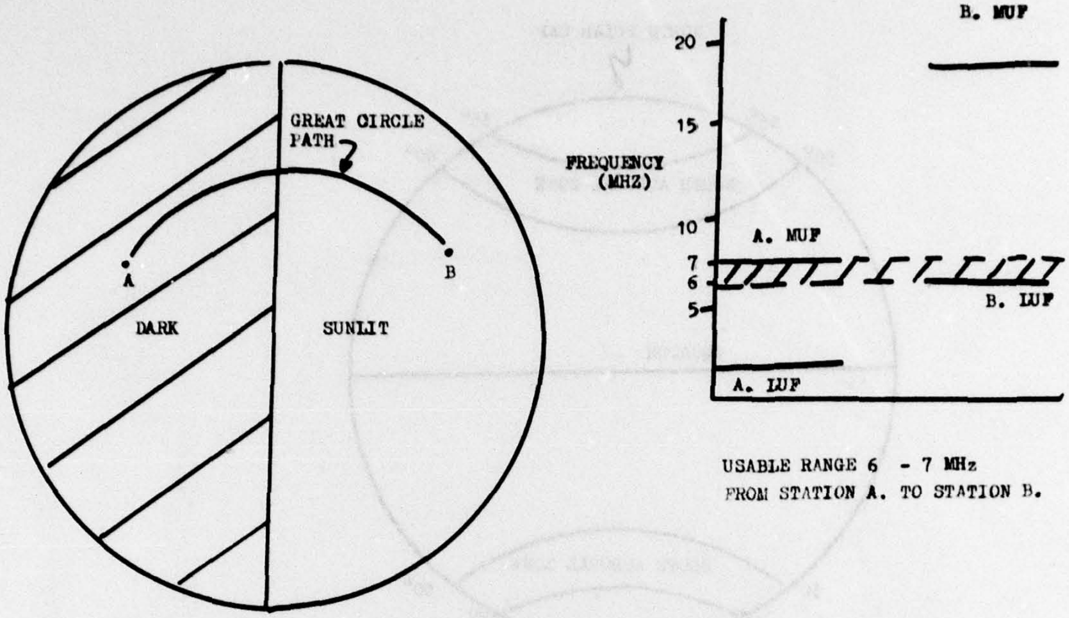
SLIDE 2. SIMPLIFIED HIGH FREQUENCY PROPAGATION MODE.



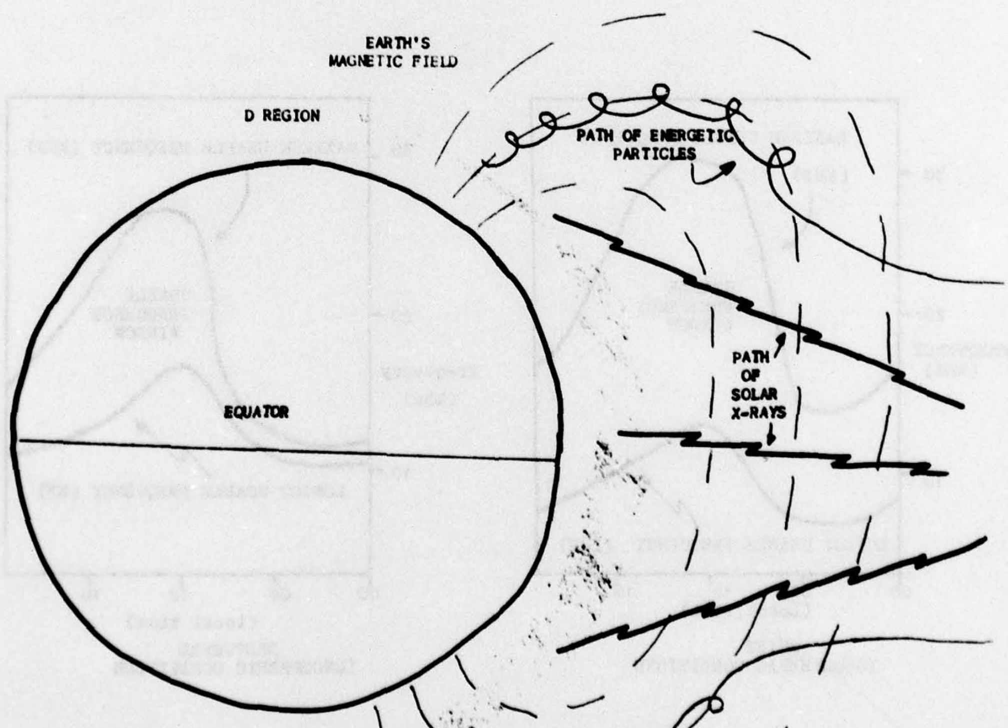
SLIDE 3. A MIXED HF PROPAGATION MODE.



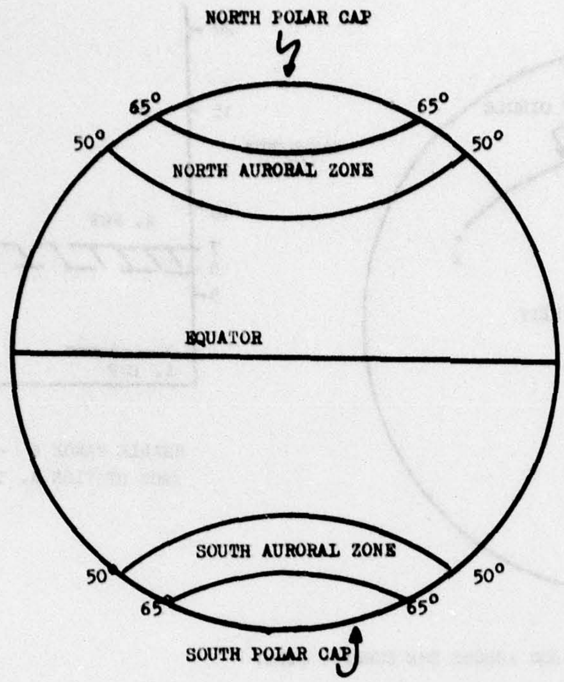
SLIDE 4. SUNRISE LINE IN THE IONOSPHERE.



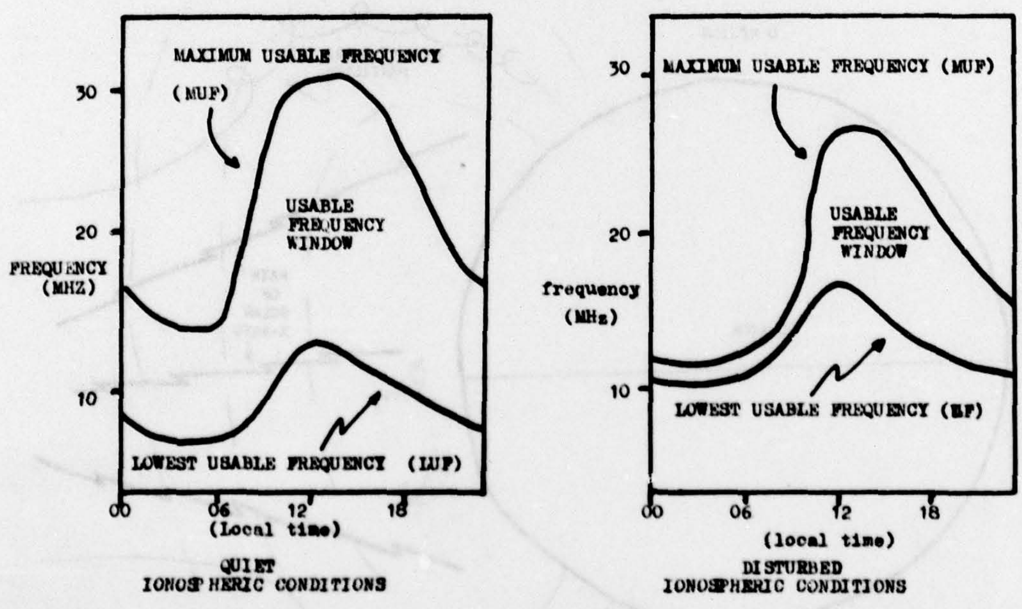
SLIDE 5. THE USABLE FREQUENCY WINDOW ACROSS THE SUNRISE LINE.



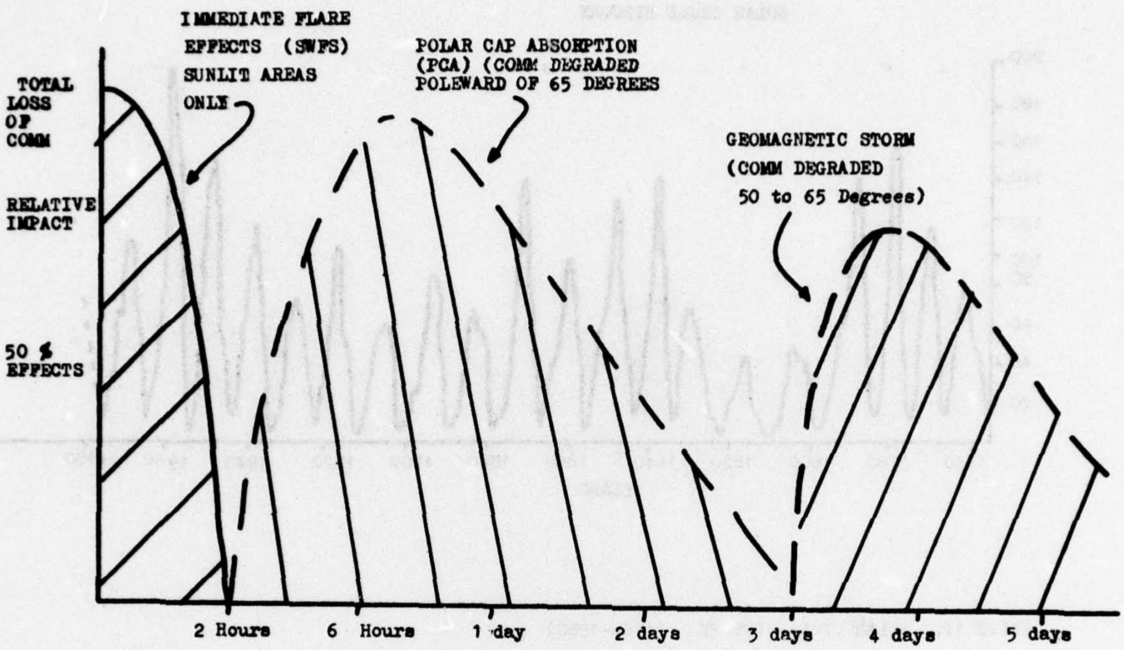
SLIDE 6. PATHS OF IONIZING RADIATIONS
FROM THE SUN.



SLIDE 7. AREAS OF THE EARTH AFFECTED BY PCAs AND GEOMAGNETIC STORMS.



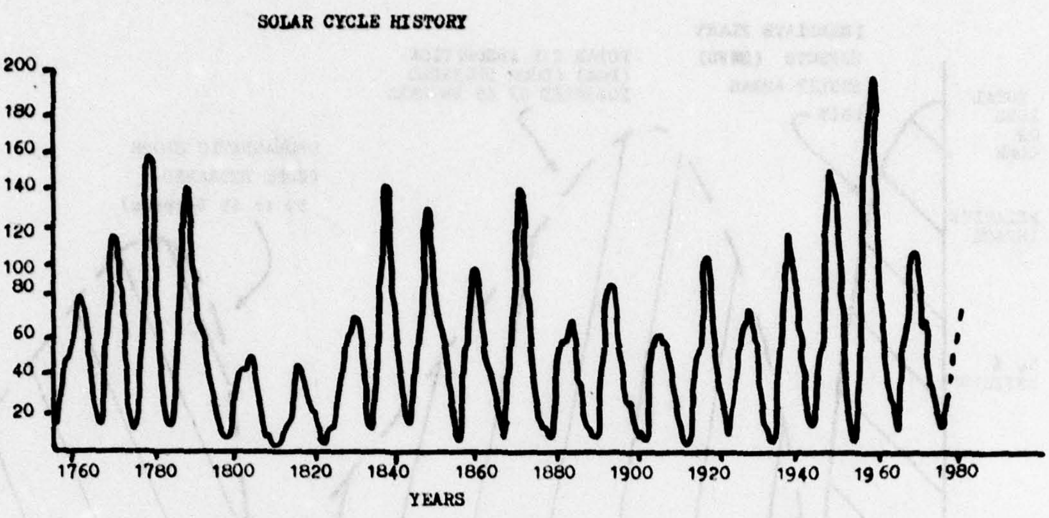
SLIDE 8. THE DEGRADATION OF COMMUNICATIONS WITH DISTURBED IONOSPHERIC CONDITIONS.



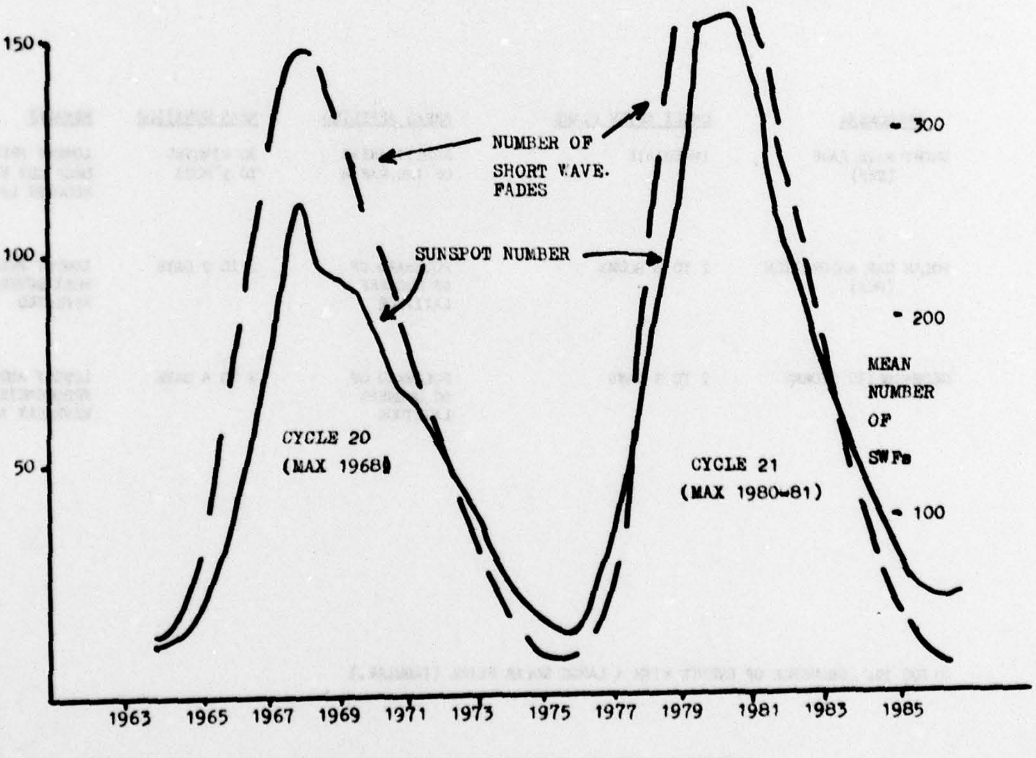
SLIDE 9. A SEQUENCE OF EVENTS WITH A LARGE SOLAR FLARE.

PHENOMENA	ONSET AFTER FLARE	AREAS AFFECTED	MEAN DURATION	REMARKS
SHORT WAVE FADE (SWF)	IMMEDIATE	SUNLIT AREAS OF THE EARTH	30 MINUTES TO 1 HOUR	LOWEST FREQUENCIES DROP OUT FIRST RECOVER LAST
POLAR CAP ABSORPTION (PCA)	2 TO 6 HOURS	POLEWARD OF 65 DEGREES LATITUDE	2 TO 3 DAYS	LOWEST FREQUENCIES MOST SEVERELY AFFECTED
GEOMAGNETIC STORMS	2 TO 3 DAYS	POLEWARD OF 50 DEGREES LATITUDE	3 TO 4 DAYS	LOWEST AND HIGHEST FREQUENCIES MOST SEVERELY AFFECTED

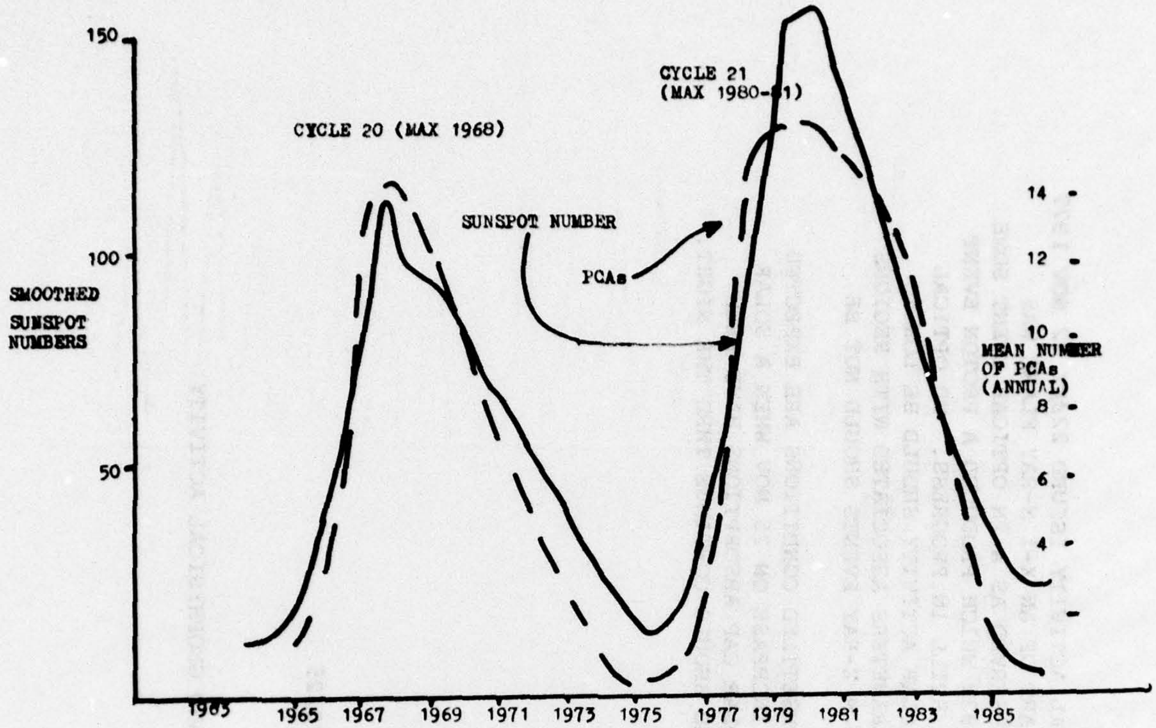
SLIDE 10. SEQUENCE OF EVENTS WITH A LARGE SOLAR FLARE (TABULAR.)



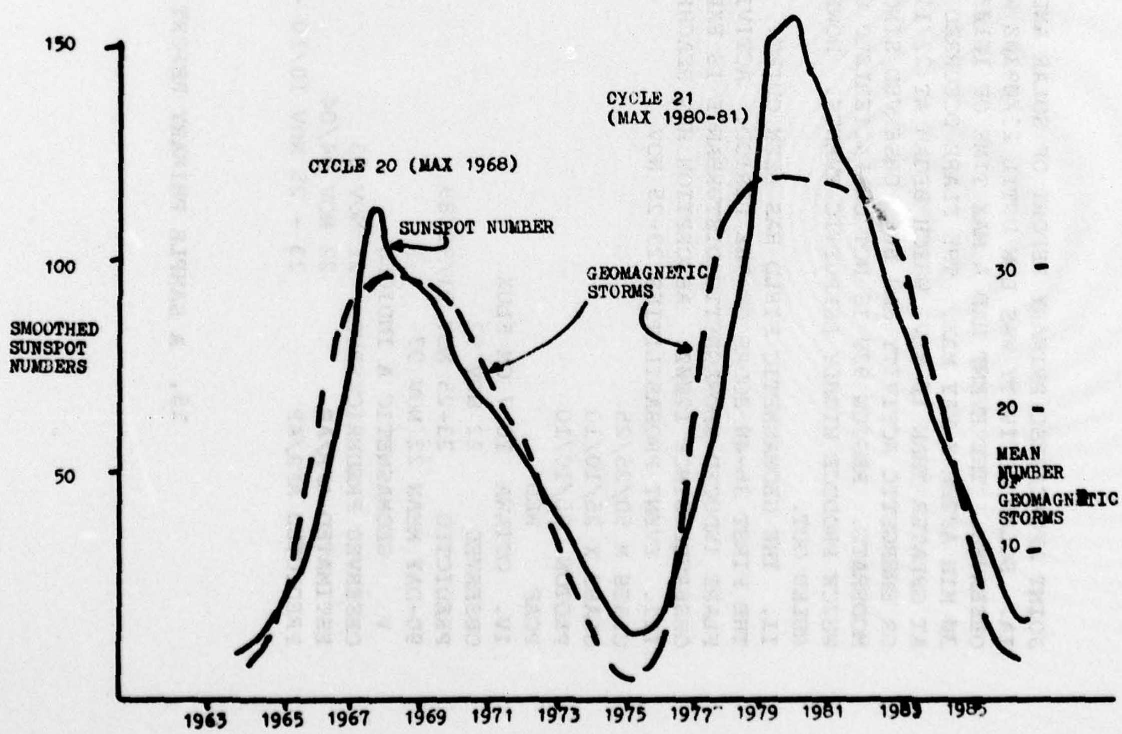
SLIDE 11. SOLAR CYCLE HISTORY (1760-1980)



SLIDE 12. NUMBER OF SHORT WAVE FADES WITH SUNSPOT NUMBERS.



SLIDE 13. Number of polar cap absorption (PCA) events with sunspot number.



SLIDE 14. NUMBER OF GEOMAGNETIC STORMS (FLARE ASSOCIATED) WITH SUNSPOT VARIATIONS.

JOINT AFGWC/SESC PRIMARY REPORT OF SOLAR AND GEOPHYSICAL ACTIVITY ISSUED 22ØØZ 22 NOV 1977

IA. SOLAR ACTIVITY WAS LOW UNTIL 22/Ø93ØZ WHEN THE START OF AN X-1 X-RAY FLARE WAS OBSERVED. THE EVENT HAD A MAX TIME OF 1Ø1ØZ AND WAS OBSERVED AS A 2N OPTICAL EVENT SOME 3Ø MIN AFTER X-RAY MAX. THE FLARE OCCURRED IN REGION 939 WHICH PRODUCED A PROTON EVENT AT GREATER THAN 1Ø MEV, WHICH BEGAN AT 22/1130Z AND IS STILL IN PROGRESS. NO OPTICAL OR ENERGETIC ACTIVITY HAS BEEN OBSERVED SINCE. IB. SOLAR ACTIVITY SHOULD BE LOW TO MODERATE. REGION 939 IS NOT CHARACTERIZED BY THOSE PARAMETERS ASSOCIATED WITH REGIONS WHICH PRODUCE HIGHLY ENERGETIC EVENTS. HOWEVER, CLASS M X-RAY EVENTS SHOULD NOT BE RULED OUT.

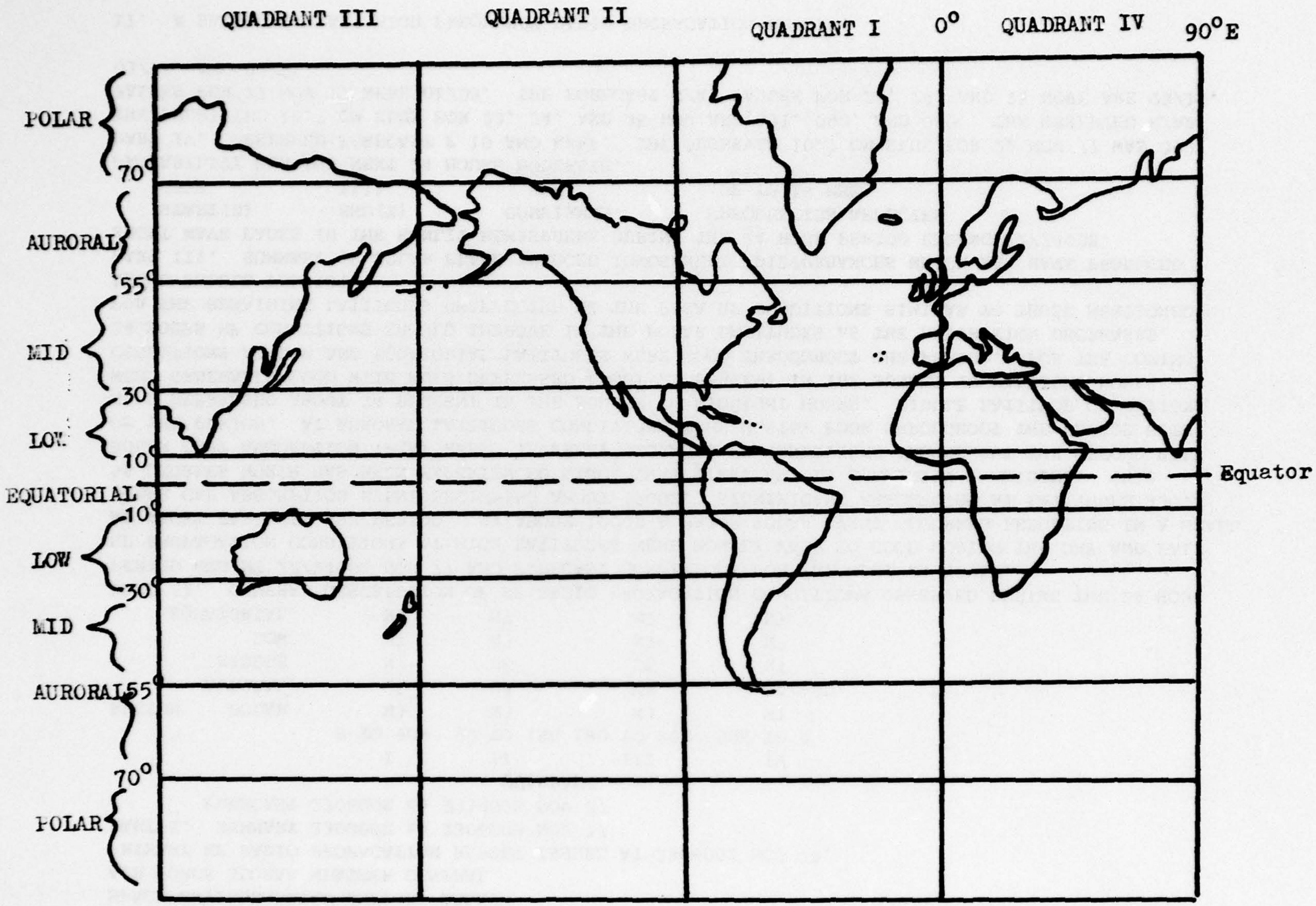
II. THE GEOMAGNETIC FIELD HAS BEEN QUIET. QUIET TO UNSETTLED CONDITIONS ARE EXPECTED THE FIRST 36-48 HOURS OF THE PERIOD. ACTIVITY SHOULD INCREASE ON 25 NOV WHEN A SOLAR FLARE INDUCED GEOMAGNETIC DISTURBANCE IS EXPECTED. POLAR CAP ABSORPTIONS HAVE BEEN OBSERVED SINCE 12ØØZ. ABSORPTION HAS REACHED .7 DB AND SHOULD CONTINUE THRU THE NIGHT.

III. EVENT PROBABILITIES 23-25 NOV
CLASS M 50/25/25
CLASS X 25/10/10
PROTON 30/10/10
PCAF RED

IV. OTTAWA 10.7 CM FLUX
OBSERVED 22 NOV 92
PREDICTED 23-25 NOV 91/90/89
90-DAY MEAN 22 NOV 97

V GEOMAGNETIC A INDICES
OBSERVED FREDERICKSBURG 21 NOV 03
ESTIMATED AFR/AP 22 NOV 04/04
PREDICTED AFR/AP 23 - 25 NOV 10/10 - 12/15 - 22/25

15. A SAMPLE PRIMARY REPORT OF SOLAR AND GEOPHYSICAL ACTIVITY.



SLIDE 16. SECTORS OF EARTH FOR WHICH HF FORECASTS ARE MADE,

SUBJ: HF RADIO PROPAGATION REPORT
SPACE ENVIRONMENTAL SUPPORT BRANCH
AIR FORCE GLOBAL WEATHER CENTRAL
PRIMARY HF RADIO PROPAGATION REPORT ISSUED AT 230600Z NOV 77.
PART I. SUMMARY 230000Z to 230600Z NOV 77
FORECAST 230600Z to 231200Z NOV 77

	QUADRANT I	II	III	IV
	0 TO 90W	90 TO 180	180 TO 90E	90E TO 0
REGION POLAR	W3	W3	W3	W3
AURORAL	U5	U4	U4	U4/-20
MIDDLE	N7	U6	U6	N7
LOW	N7	N7	N7	N7
EQUATORIAL	N7	N7	N7	N7

PART II. GENERAL DESCRIPTION OF HF RADIO PROPAGATION CONDITIONS OBSERVED DURING THE 24 HOUR PERIOD ENDING 22/2400Z NOV 77 AND FORECAST CONDITIONS FOR THE NEXT 24 HOURS.
HF PROPAGATION CONDITIONS AT HIGH LATITUDES WERE MOSTLY FAIR TO GOOD DURING THE DAY AND FAIR AT NIGHT EARLY IN THE PERIOD. AT ABOUT 1000Z A MAJOR SOLAR EVENT OCCURRED RESULTING IN A SMALL POLAR CAP ABSORPTION EVENT BEGINNING ABOUT 1600Z. SIGNIFICANT ABSORPTION AT LATITUDES ABOVE 55 DEGREES NORTH HAS BEEN EXPERIENCED SINCE THAT TIME, BUT IS CURRENTLY SUBSIDING. THIS POLAR CAPT ABSORPTION (PCA) EVENT SEVERELY DEGRADED HF CONDITIONS THROUGHOUT THE SECOND HALF OF THE PERIOD. AT AURORAL LATITUDES CONDITIONS WERE MOSTLY POOR THROUGHOUT THE PERIOD WITH MUFS DEPRESSED ABOUT 24 PERCENT IN THE SUNSET TO MIDNIGHT HOURS. MIDDLE LATITUDE CONDITIONS WERE GENERALLY GOOD WITH MUFS DEPRESSED ABOUT 25 PERCENT IN THE SUNSET TO MIDNIGHT HOURS. CONDITIONS AT LOW AND EQUATORIAL LATITUDES WERE GOOD THROUGHOUT THE PERIOD. FOR THE COMING 24 HOURS HF CONDITIONS SHOULD IMPROVE IN THE POLAR LATITUDES AS THE ABSORPTION DECREASES. FOR THE REMAINING LATITUDES UNAFFECTED BY THE PACA HF CONDITIONS SIMILAR TO THOSE MENTIONED ABOVE SHOULD PERSIST.
PART III. SUMMARY OF SOLAR FLARE INDUCED IONOSPHERIC DISTURBANCES WHICH MAY HAVE PRODUCED SHORT WAVE FADES IN THE SUNLIT HEMISPHERE DURING THE 24 HOUR PERIOD ENDING 22/2400Z.

START(Z)	END(Z)	CONFIRMED	FREQUENCIES AFFECTED
0958	1111	YES	UP TO 18 MHZ

PROBABILITY FOR THE NEXT 24 HOURS MODERATE.
PART IV. OBSERVED FORECAST F 10 AND K/AP. THE OBSERVED 10.7 CM FLUX FOR 22 NOV 77 WAS 092. THE PREDICTED 10.7 CM FLUX FOR 23, 24, AND 25 NOV ARE 091. 090, AND 089. THE OBSERVED K/AP VALUES FOR 22 NOV 77 WERE 01/03. THE FORECAST K/AP VALUES FOR 23, 24, AND 25 NOVE ARE 03/10, 03/15, AND 04/25.

17. A SAMPLE PRIMARY HIGH FREQUENCY RADIO PROPAGATION REPORT.

SUBJ: AFGWC EVENT WARNING REPORT
AFGWC EVENT WARNING REPORT ISSUED 221040Z NOV 1977.
A. SOLAR GEOPHYSICAL EVENT.
A SOLAR X-RAY FLARE BEGAN NEAR 220950Z AND PRODUCED STRONG SHORT WAVE FADES ON FREQUENCIES UP TO ABOUT 20 MHZ. TOTAL DURATION OF THE FADES WAS ABOUT 30 MINUTES.

18. A SAMPLE AFGWC EVENT WARNING REPORT.

SUBJ: AFGWC EVENT WARNING REPORT
AFGWC EVENT WARNING REPORT ISSUED 1500Z 22 NOV 1977.
A. SOLAR GEOPHYSICAL EVENT.
THE PROTON EVENT AT SATELLITE ALTITUDES WHICH BEGAN AT 22/1000Z CONTINUES. THE FLUX OF PARTICLES GREATER THAN 50 MEV IS DECREASING, WHILE AT OTHER LOWER ENERGY LEVELS, THE FLUX IS CONSTANT. A PACA EVENT IS FORECAST TO BEGIN IN THE NEXT FEW HOURS.
B. THE FORECAST FOR THE NEXT 24 HOURS FOLLOWS:
PARTICLE FLUXES SHOULD REMAIN CONSTANT FOR THE NEXT 6 TO 9 HOURS, THEN SLOWLY BEGIN TO DECLINE.
C. THE FOLLOWING SYSTEM EFFECTS ARE EXPECTED:
HF RADIO PROPAGATION CONDITIONS WILL REMAIN GENERALLY FAIR TO GOOD AT THE LOWER LATITUDES. CONDITIONS ON POLAR PATHS WILL BECOME POOR TO VERY POOR WITH THE ONSET OF THE PCA. TRANSPOLAR VLF AND LF CIRCUITS WILL EXPERIENCE PHASE ADVANCES AND ANOMALOUS PROPAGATION WITH THE PCA. THESE CONDITIONS WILL BE MOST SEVERE DURING THE SUNLIT HOURS. SATELLITE SENSORS MAY EXPERIENCE CONTAMINATION AND ON-BOARD COMPUTER RESETS.

19. A SAMPLE AFGWC EVENT WARNING REPORT.

SUBJ: SEVEN DAY OUTLOOK ISSUED 0800Z 30 DEC 1977.
SOLAR ACTIVITY:
SOLAR ACTIVITY SHOULD BE MODERATE THROUGHOUT THE ENTIRE PERIOD.
GEOMAGNETIC ACTIVITY:
THE GEOMAGNETIC FIELD SHOULD BE UNSETTLED TO ACTIVE, REACHING STORM CONDITIONS BY THE END OF THE PERIOD.
HF PROPAGATION:
POLAR AND AURORAL LATITUDE PROPAGATION WILL BE FAIR DURING LOCAL DAYLIGHT HOURS AND FAIR TO PPOR DUE TO ENHANCED NOISE LEVELS AND ABSORPTION. CONDITIONS IN THESE AREAS WILL DETERIORATE SIGNIFICANTLY DURING THE LAST FEW DAYS OF THE OUTLOOK PERIOD. HF PROPAGATION CONDITIONS AT OTHER LATITUDES SHOULD BE GOOD EXCEPT FOR BRIEF PERIODS OF FAIR PROPAGATION DURING SUNRISE TRANSITION AT LOW AND EQUATORIAL LATITUDES.

20. A SAMPLE AFGWC SEVEN DAY OUTLOOK MESSAGE.

SUBJ: AFGWC EXTENDED PERIOD FORECAST ISSUED 02/0800Z JAN 1978.
FORECAST VALID FOR THE PERIOD 02 JAN - 29 JAN 1978.
SOLAR ACTIVITY:
SOLAR ACTIVITY IS EXPECTED TO BE MODERATE THROUGH THE FIRST HALF OF THE PERIOD, THEN LOW TO MODERATE FOR THE REMAINDER OF THE FORECAST PERIOD. SEVERAL REGIONS ON THE DISK AT PRESENT HAVE THE POTENTIAL FOR PRODUCING SIGNIFICANT FLARE ACTIVITY.
GEOMAGNETIC ACTIVITY:
GEOMAGNETIC ACTIVITY IS EXPECTED TO BE QUIET TO UNSETTLED THROUGH 04 JAN, THEN IS EXPECTED TO INCREASE FROM ACTIVE TO MINOR OR MAJOR STORM LEVELS FROM 05 TO 09 JAN. GENERALLY UNSETTLED CONDITIONS ARE EXPECTED FOR THE REMAINDER OF THE PERIOD.
HF PROPAGATION OUTLOOK VALID 02 THROUGH 09 JAN:
HF PROPAGATION CONDITIONS AT POLAR AND AURORAL LATITUDES WILL BE FAIR WITH SOME PERIODS OF POOR PROPAGATION AT LOCAL SUNRISE. HF PATHS CROSSING THE AURORAL AND POLAR LATITUDES MAY EXPERIENCE POLAR CAP ABSORPTION ASSOCIATED WITH SIGNIFICANT SOLAR FLARE ACTIVITY
HF PATHS AT LOW AND MIDDLE LATITUDES SHOULD EXPERIENCE GENERALLY GOOD PROPAGATION CONDITIONS. EQUATORIAL LATITUDE PROPAGATION WILL BE GENERALLY GOOD WITH SOME PERIODS OF FAIR PROPAGATION DURING LOCAL SUNRISE. HF PATHS IN THE DAYLIGHT SECTORS MAY EXPERIENCE SHORT WAVE FADES DURING SIGNIFICANT FLARE ACTIVITY.

21. A SAMPLE AFGWC EXTENDED PERIOD REPORT.